Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) A computing system, comprising:

a first approximation apparatus to approximate a term 2^X, wherein X is a real number, the first approximation apparatus ~~comprises~~ comprising a rounding apparatus to accept an input value, (X), that is a real number represented in floating-point format, and to compute a first rounded value, ($\lfloor X \rfloor_{integer}$), by rounding the input value, (X), using a floor technique ~~toward minus infinity~~, wherein the first rounded value, ($\lfloor X \rfloor_{integer}$), is represented in an integer format;

a memory to store a computer program that utilizes the first approximation apparatus; and

a central processing unit (CPU) to execute the computer program, the CPU ~~is~~ being cooperatively connected to the first approximation apparatus and to the memory.

2. (Canceled)

3. (Currently Amended) The system of claim 1, wherein the first approximation apparatus includes:

an integer-to-floating-point converter to accept as input ~~a~~ the first rounded value, ($\lfloor X \rfloor_{integer}$), ~~being input value (X) that is a real number represented in an integer format,~~

and to convert the first rounded value~~,~~ ($\lfloor X \rfloor_{integer}$)~~,~~ to a second rounded value~~,~~ ($\lfloor X \rfloor_{floating\text{-}point}$)~~,~~ represented in floating-point format.

4. (Currently Amended) The system of claim 1, wherein the first approximation apparatus includes:

a floating-point subtraction operator to compute the difference between ~~an~~ the input value~~,~~ (X)~~,~~ and $\lfloor X \rfloor_{floating\text{-}point}$~~,~~ which is the input value~~,~~ (X)~~,~~ rounded using the floor technique ~~toward minus infinity~~ and ~~is~~ represented in floating-point format.

5. (Currently Amended) The system of claim 1, wherein the first approximation apparatus includes a shift-left logical operator to generate a shifted $\lfloor X \rfloor_{integer}$ value by shifting ~~a~~ the first rounded value~~,~~ ($\lfloor X \rfloor_{integer}$), ~~being an input value (X) that is a real number~~ to the left by a predetermined number of bit positions.

6. (Currently Amended) The system of claim 1, wherein the first approximation apparatus includes:

a second approximation apparatus to accept ΔX as input, to approximate $2^{\Delta X}$, and to return an approximation of $2^{\Delta X}$, wherein $\Delta X = X - \lfloor X \rfloor_{floating\text{-}point}$ and $\lfloor X \rfloor_{floating\text{-}point}$ is the input value~~,~~ (X)~~,~~ rounded using the floor technique ~~toward minus infinity~~ and ~~is~~ represented in floating-point format.

7. (Currently Amended) The system of claim 6, wherein the second approximation apparatus computes the approximation of $2^{\Delta X}$ by applying Horner's method in calculating a sum of a plurality of ~~elements~~ terms of ~~a~~ the Taylor series, ~~in the equation~~ $2^{\Delta X} = \sum_{N=0}^{\infty} \frac{(\Delta X \ln 2)^{N}}{N!}$.

8. (Currently Amended) The system of claim 1, wherein the first approximation apparatus includes:

an integer addition operator to accept a shifted $\lfloor X \rfloor_{integer}$ value, being the $\lfloor X \rfloor_{integer}$ value having undergone ~~an input value (X) that is a real number represented in an integer format and undergoes~~ a bit-wise shift left operation by a predetermined number of bit positions, and an approximation of $2^{\Delta X}$, represented in floating-point format, as input, and to perform an integer addition operation on the shifted $\lfloor X \rfloor_{integer}$ value and the approximation of $2^{\Delta X}$ to generate an approximation of 2^{X}, wherein $\Delta X = X - \lfloor X \rfloor_{floating\text{-}point}$ and $\lfloor X \rfloor_{floating\text{-}point}$ is the input value, (X), rounded ~~toward minus infinity~~ using the floor technique and ~~is~~ represented in floating-point format.

9. (Currently Amended) The system of claim 1, further comprising:

a third approximation apparatus to approximate a term C^{Z}, wherein C is a constant, ~~and a~~ positive number and Z is a real number,

the third approximation apparatus using a floating-point multiplication operator to compute a product of $\log_2 C \times Z$, and feeding the product, $\log_2 C \times Z$, into the first approximation apparatus to generate an approximation of C^{Z}.

10. (Currently Amended) A method comprising:

generating a first rounded value, wherein generating the first rounded value comprises rounding an input value (X) using a floor technique and representing it in an integer format; ~~and~~

generating a second rounded value;

subtracting the second rounded value from ~~an~~ the input value, (X), to generate ΔX;

generating an approximation of $2^{\Delta X}$ and representing it in floating point format;

performing a bit-wise left shift to the first rounded value to generate a shifted value; and

approximating 2^{X} by performing an integer addition operation to add the shifted value to the approximation of $2^{\Delta X}$.

11. (Canceled)

12. (Currently Amended) The method of claim 10, wherein generating the second rounded value comprises:

converting the first rounded value, represented in an integer format, to ~~the second rounded value represented in~~ floating-point format.

13. (Currently Amended) The method of claim 10, wherein generating an approximation of $2^{\Delta X}$ comprises:

applying Horner's method in calculating a sum of a plurality of ~~elements~~ terms of ~~a~~ the Taylor series, ~~in the equation~~ $2^{\Delta X} = \sum_{N=0}^{\infty} \frac{(\Delta X \ln 2)^{N}}{N!}$.

14. (Currently Amended) The method of claim 10, wherein performing a bit-wise left shift operation to the first rounded value comprises:

shifting the first rounded value to the left by a predetermined number of bit positions so that the first rounded value occupies bit positions reserved for ~~an~~ the exponent of a floating-point value.

15. (Currently Amended) The method of claim 10, wherein approximating 2^{X} comprises:

performing an integer addition operation to add the shifted value to the approximation of $2^{\Delta X}$, such that the first rounded value, represented in integer format, is added to ~~an~~ the exponent value of the approximation of $2^{\Delta X}$, represented in floating point format~~.~~

16. (Currently Amended) A machine-readable medium comprising instructions which, when executed by a machine, cause the machine to perform operations comprising:

a first code segment to perform computations to approximate the term 2^X, wherein X is a real number; and

a second code segment to accept an input value, (X), that is a real number represented in floating-point format, to compute a rounded value, ($\lfloor X \rfloor_{integer}$), by rounding the input value, (X), using a floor technique, and to return the rounded value, ($\lfloor X \rfloor_{integer}$), which is represented in an integer format.

17. (Canceled)

18. (Currently Amended) The machine-readable medium of claim 19 ~~17~~, wherein the ~~second~~ third code segment computes the approximation of $2^{\Delta X}$ by applying Horner's method in calculating a sum of a plurality of ~~elements~~ terms of ~~a~~ the Taylor series ~~in the following equation~~, $2^{\Delta X} = \sum_{N=0}^{\infty} \frac{(\Delta X \ln 2)^{N}}{N!}$.

19. (Currently Amended) The machine-readable medium of claim 16, wherein the first code segment includes:

a third code segment to accept ΔX as input and to generate an approximation of $2^{\Delta X}$, wherein $\Delta X = X - \lfloor X \rfloor_{floating\text{-}point}$ and $\lfloor X \rfloor_{floating\text{-}point}$ is the input value (X) rounded using a floor technique and ~~is~~ represented in floating-point format.

20. (Currently Amended) The machine-readable medium of claim 16, wherein the first code segment includes:

a fourth code segment to accept a shifted $\lfloor X \rfloor_{integer}$ value, being ~~an~~ the ~~input~~ $\lfloor X \rfloor_{integer}$ value ~~(X) that is a real number represented in an integer format and undergoes~~ having undergone a bit-wise shift left operation by a predetermined number of bit positions, and an approximation of $2^{\Delta X}$ as input, and to generate an approximation 2^X by performing an integer addition operation on the shifted $\lfloor X \rfloor_{integer}$ value, represented in integer format, and the approximation of $2^{\Delta X}$, represented in floating-point format, wherein $\Delta X = X - \lfloor X \rfloor_{floating\text{-}point}$ and $\lfloor X \rfloor_{floating\text{-}point}$ is the input value (X) rounded and ~~is~~ represented in floating-point format.

21. (Currently Amended) The machine-readable medium of claim 16, further includes:

a fifth code segment to approximate a term C^Z, wherein C is a constant, ~~and a~~ positive number and Z is a real number, the fifth code segment computing a product of $\log_2 C$ x Z and feeding the product, ~~of~~ $\log_2 C$ x Z, into the first code segment to generate an approximation of C^Z.

22. (New) A computing system, comprising:

a first approximation apparatus to approximate a term 2^X, wherein the input value, (X), is a real number represented in floating-point format, the first approximation apparatus including an integer-to-floating-point converter to accept as input a first rounded value, ($\lfloor X \rfloor_{integer}$), associated with the input value, (X), and to convert the first

rounded value, ($\lfloor X \rfloor_{integer}$), to a second rounded value, ($\lfloor X \rfloor_{floating\text{-}point}$), represented in floating-point format;

a memory to store a computer program that utilizes the first approximation apparatus; and

a central processing unit (CPU) to execute the computer program, the CPU is cooperatively connected to the first approximation apparatus and the memory.

23. (New) The system of claim 22, wherein the first approximation apparatus comprises a rounding apparatus to accept (X) and to compute the first rounded value, ($\lfloor X \rfloor_{integer}$), by rounding (X) using a floor technique, the first rounded value, ($\lfloor X \rfloor_{integer}$), being represented in an integer format.

24. (New) The system of claim 22, wherein the first approximation apparatus includes:

a floating-point subtraction operator to compute the difference between the input value, (X), and the second rounded value, ($\lfloor X \rfloor_{floating\text{-}point}$).

25. (New) The system of claim 22, wherein the first approximation apparatus includes a shift-left logical operator to generate a shifted first rounded value by shifting the first rounded value, ($\lfloor X \rfloor_{integer}$), to the left by a predetermined number of bit positions.

26. (New) The system of claim 22, wherein the first approximation apparatus includes:

a second approximation apparatus to accept ΔX as input, to approximate $2^{\Delta X}$, and to return an approximation of $2^{\Delta X}$, represented in floating-point format, wherein $\Delta X = X - \lfloor X \rfloor_{\text{floating-point}}$.

27. (New) The system of claim 26, wherein the second approximation apparatus computes the approximation of $2^{\Delta X}$ by applying Horner's method in calculating a sum of a plurality of terms of the Taylor Series, $2^{\Delta X} = \sum_{N=0}^{\infty} \frac{(\Delta X \ln 2)^{\underline{N}}}{N!}$.

28. (New) The system of claim 22, wherein the first approximation apparatus includes:

an integer addition operator to accept a shifted $\lfloor X \rfloor_{\text{integer}}$ value, the $\lfloor X \rfloor_{\text{integer}}$ value after having undergone a bit-wise left shift operation so that $\lfloor X \rfloor_{\text{integer}}$ is located in a position corresponding to the exponent of a floating-point number, and an approximation of $2^{\Delta X}$ as input, and to perform an integer addition operation on the shifted $\lfloor X \rfloor_{\text{integer}}$ value, represented in integer format, and the approximation of $2^{\Delta X}$, represented in floating-point format, to generate an approximation of 2^{X}, wherein $\Delta X = X - \lfloor X \rfloor_{\text{floating-point}}$ and $\lfloor X \rfloor_{\text{floating-point}}$.

29. (New) The system of claim 22, further comprising:

a third approximation apparatus to approximate a term C^Z, wherein C is a constant and a positive number and Z is a real number, the third approximation apparatus using a floating-point multiplication operator to compute the product of $\log_2 C \times Z$, and feeding the product, $\log_2 C \times Z$, into the first approximation apparatus to generate an approximation of C^Z.

30. (New) A computing system, comprising:

a first approximation apparatus to approximate a term 2^X, wherein the input value, (X), is a real number represented in floating-point format, the first approximation apparatus including a floating-point subtraction operator to compute the difference between (X) and a first rounded value, $\lfloor X \rfloor_{\text{floating-point}}$, wherein $\lfloor X \rfloor_{\text{floating-point}}$ is (X) rounded using a floor technique and represented in floating-point format;

a memory to store a computer program that utilizes the first approximation apparatus; and

a central processing unit (CPU) to execute the computer program, the CPU is cooperatively connected to the first approximation apparatus and the memory.

31. (New) A method comprising:

generating a first rounded value;

generating a second rounded value by converting the first rounded value, represented in an integer format, to floating-point format;

subtracting the second rounded value from an input value, (X), to generate ΔX;

generating an approximation of $2^{\Delta X}$;

performing a bit-wise left shift to the first rounded value to generate a shifted value; and

approximating 2^X by performing an integer addition operation to add the shifted value, represented in integer format, to the approximation of $2^{\Delta X}$, represented in floating-point format.